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Vol. X. JUNE, 1915. Part

Transactions
of the
Mining and Geological Institute of India.

Edited by
The Honorary Treasurer.

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The RECORDS of the GEOLOGICAL SURVEY of INDIA

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Application for any of the above should be made to The Head Clerk, Geological Survey of India, 27, Chowringhee, Calcutta.

Transactions
# of the
Mining and Geological Institute of India.

Part 1.] 1915. [June.

Annual Meeting.

Held on Friday, January 29th, 1915.

The Ninth Annual General Meeting of the Mining and Geological Institute of India was held on Friday, the 29th January, 1915, at 11 a.m., in the Lecture Room of the Asiatic Society of Bengal, 1, Park Street, Calcutta. In the absence of Mr. F. J. Agabeg, President of the Institute, Lt.-Colonel F. Cunynghame Hughes, one of the Vice-Presidents, occupied the chair and the following members were present:—

Messrs. G. F. Adams, A. E. Arratoon, Chas E. Ashcroft, P. H. Ashcroft, E. S. Bennertz, R. J. Browne, L. M. Chowdhuri, N. M. Chowdhuri, W. Choudhry, W. A. K. Christie, H. M. Daly, J. H. Evans, H. G. Graves, J. Gregory, W. J. Greener, H. H. Hayden, B. Heaton, G. L. B. Henderson, S. Heslop, A. H. Higby, H. C. Jones, J. S. Kean, G. C. Leach, W. A. Lee, F. T. Marley, C. H. McCale, C. S. Middlemiss, J. A. Millar, Guy E. Pilgrim, H. C. Read, H. H. Reynolds, T. Samson, W. Simmons, R. R. Simpson, C. H. R. Thorn, J. J. Turnbull, J. B. Wardlaw, and T. P. Yeoman.

The Chairman, in opening the meeting, said that he had been requested to take the chair owing to the unavoidable absence of the President, Colonel F. J. Agabeg, who, he regretted to have to announce, was too ill to attend.

Messrs. B. Heaton and J. J. Turnbull having been appointed scrutineers to examine the voting papers for the election of office-bearers for the year 1915, the minutes of the previous Annual General Meeting and of the Ordinary General Meeting held at Charanpur on February 23rd, 1914, were read and confirmed.

The Report of the Council and the accounts for the year 1914 were then read by Dr. H. H. Hayden on behalf of Mr. H. H. Reynolds.

REPORT OF COUNCIL FOR 1914.

The Council have the honour to present the Ninth Annual Report on the working of the Mining and Geological Institute of India.

2. A decrease in Membership has to be reported this year. The additions to the register and the losses by resignations, etc., are shown on the following table:—

	1910	1911	1912	1913	1914
Additions ..	26	22	16	14	4
Losses	8	26	14	14	20
Gain	18	..	2	..	
Loss	..	4	..	..	16

It will be seen from the table that the fall in Membership is due both to a decrease in the additions and to an increase in losses.

Of Associate Members, only one was elected during the year, whilst one resigned and two were struck off (under Rule 14).

Only one Associate has joined during the year.

The following table gives the numbers for the last five years:—

	1910	1911	1912	1913	1914
Ordinary Members ..	251	247	249	249	233
Associate Members ..	17	17	15	16	14
Associates ..	7	5	6	8	9
Honorary Members ..	11	10	10	10	10
Subscribers ..	18	20	23	25	25

3. The following list gives the names and addresses of those who have joined during the year:—

Ordinary Members.

1. Chowdhry, Woopendranath ..	.. Geologist, Ph.D., 4, Sunny Park, Ballygunge.
2. Gregory, J. ..	.. Holder of first class Colliery Managers' Certificate, Bengal Iron and Steel Co., Ld., Kulti.
3. Thompson, C. ..	.. Colliery Manager, Reliance Coal Co., Ld., Charanpur, Asansol, E.I.R.
4. Turnbull, J. J. (Jr.)	.. Junior Inspector of Mines in India, Dhanbaid, E.I.R.

Associate Members.

1. Ashcroft, R. S. ..	.. Mining Engineer, Seebpore Coal Co., Ld., Charanpur, Asansol, E.I.R.

Associates.

1. Parry, A. H. ..	.. Merchant's Assistant connected with Coal trade.

4. Ten members have resigned : Messrs. J. B. Argyle, P. N. Datta, R. G. Higby, W. Hullock, F. A. S. Longley, E. Masillamani, E. S. Pinfold, G. F. Scott, J. E. Snelus and C. M. P. Wright. The following names have been removed from the list of members under Rule 14 of the Articles of Association:—Messrs. H. Adamson, P. C. Dutt, E. N. Forbes, C. T. Foreman, W. T. Griffiths, W. A. Hockly,

N. Miller, W. H. Olivant, S. C. Rai Chaudhury, A. Sheridan, C. L. Watson, E. B. D. White and Geo. Wills.

5. Meetings of the Institute were held as follows:—

Annual General Meeting, Calcutta, 30th January. 1914.
Ordinary ,, ,, Sara, 31st January, 1914.
,, ,, ,, Charanpur, 23rd February, 1914.

The Ordinary General Meeting of the 31st January was held to make an excursion to visit the Lower Ganges Bridge which was under construction at Sara. The meeting at Charanpur was held by the kind invitation of Messrs. Apcar & Co., to visit their Charanpur Colliery, Asansol.

6. Two parts of the Transactions have been issued, forming part 2 of Vol. VIII, and part 1 of Vol. IX. Vol. VIII, part 2, was issued to members on 25th July and Vol. IX, part 1, on the 25th September 1914.

7. Six Council meetings have been held during the year for the election of members and transaction of the current business of the Institute.

8. The geological map of the Raniganj Coal-field, complete in 24 sheets on a scale of 4″=1 mile, which is the outcome of the work for several years of the Raniganj Map Committee, has been published. Price Rs. 48 per set, unbound. The above map on a scale of 1″=1 mile has also been published and issued to members on 7th August 1914. Price Rs. 6, bound.

9. Considerable progress with the work of the Jharia Map Committee has been made. The Committee's surveyor has mapped the lower seams between Kusunda and the Katri River and between Dobari and Jinagora. He has also mapped all seams between the Katri and the Jamuni River. Finished sheets for the Bhowra area and the Kusunda-Kustor area have been submitted by Messrs. R. J. Browne and E. S. Bennertz respectively. Elsewhere

progress has been unsatisfactory, but since a meeting of the Committee held in November, the activity of the Sub-Committees responsible for the work has been renewed. Until such time as finished sheets for all the areas have been sent in by the Sub-Committees, and the work of co-ordinating the results has been commenced no estimate of the date of the completion of the work can be made.

10. *Local Meetings.*—At the Asansol branch, only one meeting was called on the 31st August 1914, to discuss the following papers:—

(*a*) Note on the Geological Re-Survey of the Raniganj Coalfields. By Mr. H. Walker.
(*b*) Manufacture of Explosives. By Mr. Macqueen.
(*c*) Supporting Shaft Sides through a Fault. By Messrs. J. H. Evans and Glen George.

Mr. F. J. Agabeg, the President, was in the Chair; very few members attended.

At the Jharia Centre, a field geology meeting was held on the 16th February 1914. At this an attempt was made to trace the outcrops of the seams known as Nos. 10, 11, 12, 13 and 14 extending from Jharia Station to Lodna Colliery; an interesting discussion took place in which the members present took part.

A meeting was arranged for the 28th August 1914, to discuss the papers mentioned above. The papers were circulated to the local members with a notice calling the meeting, but there was no response.

11. Two meetings of the Subsidence Committee have been held and the general procedure to be followed for acquiring information has been decided upon. A Surveyor has been selected and the purchase of necessary instruments for his use is being negotiated. A circular letter will be sent shortly to the Agents or Managers of all

important collieries, asking them to notify the Honorary Secretary of the Committee (the Chief Inspector of Mines in India) at Dhanbaid of any goafing operations or sudden subsidences.

12. The prize offered by the Government of India for the best paper read before the Institute was awarded to Mr. E. S. Tarlton for his paper on "Transport and Screening of Coal at Saltore Colliery."

13. *Institute Prizes.*—The Council offered for this year three prizes, each consisting of books to the value of Rs. 100 for the best paper on the following subjects, *viz.*: (*a*) Laying out a Pit Bottom for an Indian Colliery, (*b*) Housing and Sanitation of Mine Labour in India, and (*c*) The Application of the Various Systems of Haulage to Indian Mines; but papers dealing with first-named subject only have been received for competition.

14. The following is the financial statement for the year 1914. The revenue of the Institute for 1914 is Rs. 10,811-0-6, the expenditure Rs. 10,150-13-8, leaving a balance of Rs. 660-2-10. In addition, Rs. 165, resulting from the realization of entrance fees, has been credited to Capital. The income from subscriptions was Rs. 7,643-5-4, and the balance of the income was derived from interest on funds and sales of publications, advertisement, etc. The heaviest items of expenditure are in connection with the Raniganj and Jharia Maps, and the publication of the Transactions, which amount to Rs. 2,372-10-1, Rs. 1,260-5-10 and Rs. 1,722-9-6 respectively.

The Chairman then proposed that the Report of the Council as read and the Accounts for the year 1914 as put before the members be passed and adopted. This was econded by Mr. R. J. Browne and carried unanimously.

MINING AND GEOLOGICAL INSTITUTE OF INDIA.

Balance Sheet as at 31st December, 1914.

LIABILITIES.		Rs.	A.	P.	Rs.	A.	P.
Capital Account—							
Balance of last year's account ..		10,845	0	0			
Add: Entrance Fees of—							
4 Ordinary Members @ 30/-	120 0 0						
1 Associate Member @ 15/-	15 0 0						
1 Associate @ 30/-	30 0 0						
		165	0	0	11,010	0	0
Reserve Account—							
28 Life Members paid in advance ..		..	..	..	1,443	5	4
Sundry Liabilities		..	..	..	591	12	0
Suspense		..	..	..	15	0	0
Indian Mining and Geological Club ..		..	..	..	1	14	0
Provident Fund		..	..	..	391	0	4
Library Deposit Fee from Members ..		..	..	..	10	0	0
Revenue Account—							
Balance as at 1st January, 1914 ..		22,773	2	11			
Add: Surplus during the year ..		660	2	10			
					23,433	5	9
TOTAL, RS. ..		..	..	..	36,896	5	5

ASSETS.		Rs.	A.	P.	Rs.	A.	P.
Value of Publications in Stock—							
As per last Account		498	13	0			
Added during the year		138	4	0			
		637	1	0			
Less: Depreciation written off ..		159	4	3			
					477	12	9
Outstanding Bills		..	..	..	249	0	0
Outstanding Subscriptions for 1914 ..		..	..	..	785	12	0
Furniture—							
As per last account		471	15	0			
Purchased during the year ..		360	0	0			
		831	15	0			
Less: Depreciation written off ..		166	6	0			
					665	9	0
Fixed Deposits—							
With the National Bank of India, Ld.		22,000	0	0			
Interest accrued		323	1	1			
		22,323	1	1			
With the Alliance Bank of Simla, Ld.	4,000 0 0						
Interest accrued ..	25 6 9						
		4,025	6	9			
					26,348	7	10
Cash—							
With the National Bank of India, Ld.		8,280	8	3			
,, Honorary Secretary ..		14	0	6			
,, ,, ,, Jharia							
Map Committee ..		75	3	1			
					8,369	11	10
TOTAL, RS. ..					36,896	5	5

We hereby certify that we have examined the Books and Accounts of the Mining and Geological Institute of India with the Vouchers for the year ended 31st December, 1914, and have found them correct. In our opinion the above Balance Sheet is drawn up in conformity with the law and exhibits a true and correct view of the position of the Institute to the best of our information and the explanations given to us and as shown by the books.

Calcutta, 9th January, 1915. (*Sd.*) LOVELOCK & LEWES, *Chartered Accountants, Auditors.*

MINING AND GEOLOGICAL INSTITUTE OF INDIA.

Income and Expenditure Account for the year ended 31st December, 1914.

EXPENDITURE.	Rs.	A.	P.	Rs.	A.	P.
To Advertising, Printing and Stationery	..	..	..	1,969	8	0
,, Dinner Account	..	..	..	449	8	0
,, Postages and Telegrams ..	..	..	..	314	12	9
,, Raniganj Coalfield Geological Map Account	..	..	..	2,372	10	1
,, Jharia Coalfield Geological Map Account	..	..	..	1,260	5	10
,, Charges, General	..	..	..	559	2	6
,, Establishment	..	..	..	1,488	13	3
,, Rent	..	..	..	974	0	0
,, Binding of Books	..	..	..	35	13	0
,, Subsidence	..	..	..	10	10	0
,, Subscription for 1913 written off ..	..	..	..	390	0	0
,, Depreciation written off Books ..	159	4	3			
,, ,, ,, ,, Furniture	166	6	0			
				325	10	3
,, Balance transferred to Balance Sheet	..	..	..	660	2	10
TOTAL, Rs ..	..	..	..	10,811	0	6

INCOME.	Rs.	A.	P.	Rs.	A.	P.
By Subscriptions—						
216 Ordinary Members @ 30/- ..	6,480	0	0			
4 ,, ,, @ 20/- ..	80	0	0			
14 Associate ,, @ 15/- ..	210	0	0			
8 Associates @ 30/- ..	240	0	0			
25 Subscribers	633	5	4			
				7,643	5	4
,, Sale of Maps	..	..	..	1,536	9	6
,, Interest	..	..	..	1,223	1	8
,, Advertisement and Sale of Books..	..	..	..	350	0	0
,, Excursion	..	..	..	58	0	0
TOTAL, Rs. ..	..	..	..	10,811	0	6

Examined and found correct

Calcutta, 9th January, 1915.

(*Sd.*) LOVELOCK & LEWES, *Chartered Accountants, Auditors.*

The Judging Committee's awards for the best papers offered to the Institute were then read; the Government Prize of Rs. 500 was divided equally between Dr. A. W. G. Bleeck for his paper on "Contributory Notes to the Economic Geology and the Results of Petroleum Borings in the Minbu Oilfield", and Mr. T. S. Gibson for his paper on "Proposals for Shaft Bottom Arrangements and Methods of Working in Deep Seams." Of the three Institute Prizes of Rs. 100 each offered on three different subjects, papers were submitted dealing with one subject only, viz. "Laying out a Pit Bottom for an Indian Colliery", and the prize was awarded to Mr. R. H. Husband for his paper on that subject.

REPORT OF THE JUDGING COMMITTEE OF PAPERS RECEIVED DURING THE YEAR 1914.

Present:—Messrs. G. F. Adams, A. C. Banerjee, J. S. Kean and C. S. Middlemiss.

The Committee are of opinion that the paper on the "Manufacture of Explosives", by Mr. W. P. O. Macqueen, is of novel interest and well written, but as Mr. Macqueen does not belong to the Institute in any Class, the Committee regret they have been unable to consider it in connection with the Government Prize.

The Committee consider that the Government Prize should be equally divided between Dr. A. W. G. Bleeck for his paper on "Contributory Notes to the Economic Geology and the Results of Petroleum Borings on the Minbu Oilfield", and Mr. T. S. Gibson for his paper on "Proposals for Shaft Bottom Arrangements and Methods of Working in Deep Seams."

The Committee consider that the Institute Prize of Rs. 100 for "Laying out a Pit Bottom for an Indian Colliery" should be awarded to Mr. R. H. Husband.

(Signed) G. F. ADAMS.
(,,) A. C. BANERJEE.
(,,) J. S. KEAN.
(,,) C. S. MIDDLEMISS.

Pending the completion of the examination of the voting papers, discussion was opened on the following papers :—

(1) Notes on the Geological Re-Survey of the Raniganj Coalfield. By H Walker, F.G.S.

(2) Manufacture of Explosives. By W .P. O. Macqueen.

(3) Supporting Shaft Sides through a Fault. By J. H. Evans and Glen George.

With regard to the first, Mr. R. R. Simpson remarked that he would like to ask Mr. Walker if he proposed to publish any sections in connection with his paper. There were, he knew, a number of sections sent in by Managing Agents, but he was not aware if they were available for publication.

Dr. H. H. Hayden, replying on behalf of Mr. Walker, said that he did not know the exact arrangement that had been come to in the matter, but would be glad to take the matter up and have sections drawn, provided that managers and owners had no objection to their publication. It would presumably be necessary to approach the owners of the properties first.

Mr. Simpson said he did not think it was necessary to draw geological sections, but he suggested that some of the boring sections should be printed and be made available to members. He had several enquiries for boring sections which he knew to be in the records of the Institute, but in certain cases these were at present confidential. If the boring sections were printed and published that would meet the case.

The Honorary Secretary pointed out that the boring sections had been drawn in his office and were ready for reproduction, if required. The work was not quite finished, as sections had been sent in on scraps of paper and on different scales, and it was necessary to have them all drawn to one scale.

The Chairman then suggested that the discussion of the above papers should be postponed to the next meeting; members being requested either to send in written discussions on the papers or to reserve their remarks for the next meeting.

The Chairman announced that it had been resolved by the Council that the three Institute Prizes of Rs. 100 should be open again for the coming year, but that the subject of "Metal Mining or Geology connected therewith" be substituted for "Laying out of a shaft bottom", the latter subject having been dealt with fully during the past year.

The resolution of the Council that the prizes be continued during the coming year and that the subject of "Metal Mining or Geology connected therewith" be substituted for "Laying out of a pit bottom" was then put to vote and carried uuanimously.

The Chairman next called upon the Honorary Secretary to report the result of the voting for Council and Officers for the year 1915.

The Honorary Secretary declared the election to be as follows:—

President:

H. H. Hayden, C.I.E., D.SC., B.A., B.A.I. (T.C.D.), F.G.S, Director, Geological Survey of India.

Vice-Presidents:

Glen George, B.SC., A.M.I.C.E., Chief Mining Engineer, Bengal Coal Co.

Hon'ble Mr. W. A. Lee, Messrs. W. A. Lee & Co.

Honorary Treasurer and Editor of Transactions:

H. Walker, A.R.C.S., A.I.M.M., F.G.S., Asst. Supdt., Geological Survey of India.

Honorary Secretary:

H. H. Reynolds, M.I E.E., Consulting Engineer.

Council:

A. C. Banerjee, M.A., Messrs. A. C. Banerjee & Co.
R. Barrowman, Manager, Standard Coal Co., Ld.
R. G. M. Bathgate, F.G.S., General Manager, East Indian Coal Co.
H. D. Coggan, Manager, Central India Mining Co., Ld.
L. L. Fermor, A.R.S.M., D.SC., F.G.S., Superintendent, Geological Survey of India.
W. J. Greener, Messrs. Bird & Co.
J. S. Kean, Genl. Manager, Raniganj Coal Association.
G. C. Leach, M.I.M.E., A.I.E.E., Inspector of Mines in India.
C. H. McCale, Manager, Damuda Coal Co., Ld
C. S. Middlemiss, B.A. (Cantab), F.G.S., Superintendent, Geological Survey of India.
F. Owen, Superintendent, Equitable Coal Co., Ld.
W. H. Phillips, M.I.M.E., F.G.S., Manager, Bikanir State Mines.
C. H. Richards, M.I.M.M., Superintendent, Nundydroog Mine.
T. Samson, M.I.M.E., Manager, S. E. Baraboni Colliery.
W. J. Wood, Messrs. Shaw Wallace & Co.

Lieut.-Colonel F. Cunynghame Hughes then called upon the new President to take the Chair.

Dr. H. H. Hayden, the newly-elected President, then took the Chair.

Mr. Simpson: I have pleasure in proposing a cordial vote of thanks to the retiring President and Members of Council. When I last saw Colonel Agabeg he was commanding his force in the field, and I trust that his illness will not prove serious and that his absence from amongst us will only be temporary.

Mr. Ashcroft: I have pleasure in seconding that.

The President: Colonel Agabeg is particularly sorry that he cannot come to-day; he has been seriously ill and I am sure we all greatly regret his absence and more particularly the cause of it. I have no doubt that the vote of thanks will be unanimously approved by the Institute.

The vote of thanks was then put to the meeting and carried unanimously.

The President then delivered his presidential address.

Presidential Address.

BY

H. H. Hayden, C.I.E., D.Sc.

Gentlemen,—I must first of all thank you for the honour that you have done me in electing me your President—an honour that I feel the more deeply in that it implies that the original purpose of our Institute which was to draw together the two related, but so often conflicting, aspects of mining science, the theoretical and the practical, has not been lost sight of, and that the alliance between the two has not merely stood the test of time but has grown stronger with the years.

This, gentlemen, is the tenth occasion on which we have met, for the Institute has now completed nine years of existence and enters to-day on its tenth. It has passed through the difficult and dangerous period of childhood, watched over in its infancy by its parents, the late Mr. Pickering and Sir Thomas Holland, but tended always with unceasing vigilance by its nurses, Mr. Graves, Mr. Pringle and Mr. Reynolds, who one after another have devoted their time and their unremitting energies to a task the difficulties of which can only be realized by those who have performed it themselves. The Secretaryship of an Institute of this kind is no sinecure, it involves much anxiety and responsibility, and our debt to those who have held it, as Mr. Reynolds has done, for many years, is no small one.

In a country so large as India, where distances between the various mining and industrial centres are so great, it is impossible to bring together at any one meeting members representing all the interests with which our Institute is connected and embracing such widely-separated areas as Burma and Baluchistan, Mysore and Assam. Nor has it been found possible yet to hold meetings at the more distant centres where there are only a few members; the result has been, therefore, that meetings have been held chiefly around the area from which the overwhelming majority of the members is derived, viz., Calcutta and the Bengal coalfields. There is thus a tendency to overlook certain branches of industry which are less numerously represented but are none the less important, and there is danger of our allowing our interest to become concentrated too much in one direction and of our thus losing sight of the main object of our Institute as defined in the Articles of Association—"to promote the study of all branches of mining, geology, metallurgy and engineering in India with a view to disseminate the information obtained for facilitating the scientific and economic development of the mineral industries of India."

Handicapped as we are by the great distances between the various mining centres and communities, we find it necessarily a matter of great difficulty to keep our component units mutually in touch—an end which is attained readily in other countries by means of frequent meetings for the reading of papers and for discussion. We must, therefore, find other means to reach the same end, and an attempt has been made to do this by holding branch meetings at local centres. Although promising success at first, the meetings have latterly proved disappointing, and it now seems doubtful that they will bring about the results that we had hoped.

One bond, however, has always united us and will, I hope, continue to do so with increasing strength. That bond is our *Transactions*, and is one which, I think, should be capable of considerable development; such development, however, will only be possible with the cordial sympathy and co-operation of you all; for that sympathy and co-operation I now ask you on behalf of the Institute, and I hope that you will give it in the form of papers for publication in the *Transactions*. Descriptions of local mineral deposits, mines, processes, labour and all the numerous problems that crop up in the course of discovering, opening up and working a mineral deposit, are of interest and value not only to those directly concerned in a particular district or even in India, but to all engaged in similar work throughout the world, and I would urge members to write for us descriptive accounts of the particular properties with which they are connected, where the publication of such descriptions may be permitted by the companies or individuals concerned.

Another direction in which I hope we may be able to develop our *Transactions* is the publication of abstracts of current literature. Many of those working in parts of India far removed from the larger towns cannot but feel the need of a library; this want can be to some extent relieved by access to ample reviews of, and abstracts from, current literature. In the earlier numbers of the *Transactions*, such abstracts were published from time to time, but the custom has fallen into disuse of late, and it is one which can, I feel sure, be revived with profit to us all. I would, therefore, ask members who happen to meet with any paper that they consider of interest, to send either its title or preferably an abstract of it to the Editor of our *Transactions*. In this way, I hope, we may be able to add to the interest of our publications and to compensate to some extent for the difficulty of bringing together our members from the far-distant parts of the Indian Empire.

Last year the membership of the Institute fell appreciably for the first time. Inaugurated with an original membership of 172 in 1906, the numbers rose steadily to 304 in 1910, and finally to 308 in 1913. They have now fallen to 291. All societies such as ours, however, are inevitably subject to fluctuations in their numbers from time to time, and I hope the present year will see an increase up to our former maximum and even beyond it.

It is now just eight years since Sir Thomas Holland in his second presidential address to this Institute[1] reviewed the position of the mineral industry of India as it then stood, and was able to state that during the two preceding years the activity in mineral development in India had been greater than at any previous time in the history of the country. I propose to-day to take stock once more of our position in this respect and to consider to what extent and in what directions the promise of those earlier years has been fulfilled.

If we compare first of all the figures for the total value of the mineral production of India for the respective years 1905, the last for which figures were available to Sir Thomas Holland, and 1913, the last for which figures are available to us now, we find a rise from about 5¾ million pounds sterling to 10 millions, or an increase of 75 per cent in a period of eight years; this is undoubtedly a measure of progress which may well give unalloyed satisfaction to all those interested in the development of the mineral resources of the Indian Empire. The success achieved, however, is but a fraction of what still remains to be done, as a brief analysis of the chief items that go to make up the total mineral production of India will show.

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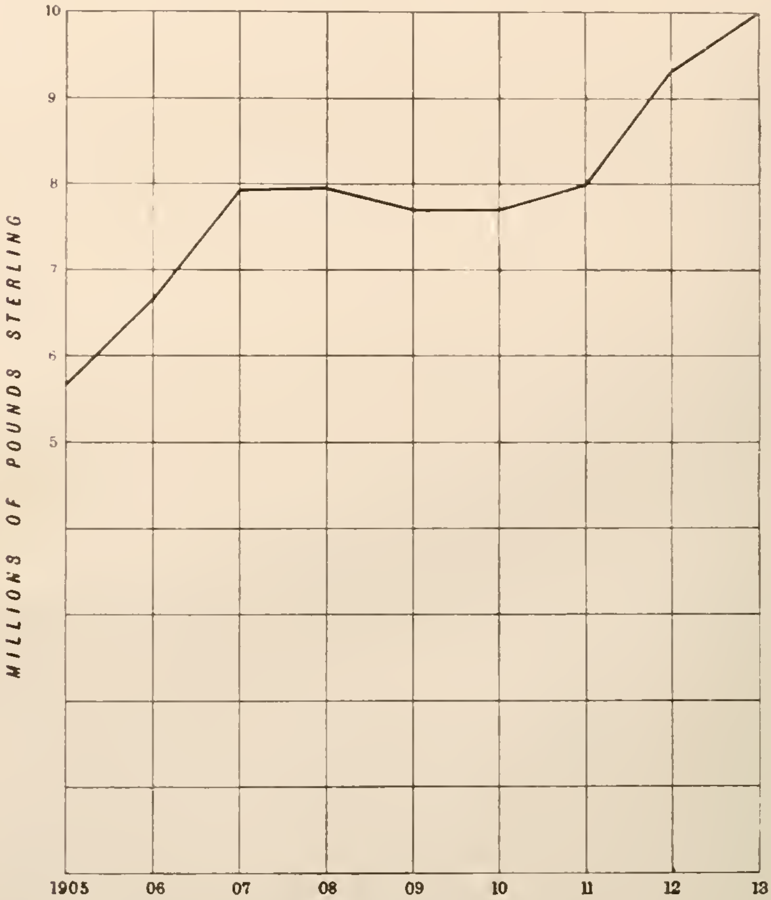
[1] Trans., Min. Geol. Inst. of India, Vol II, pp. 21-43.



I Curve showing variations in the total value of the Mineral Production of India between the years 1905 and 1913.

If we compare the figures for the year 1905 with those for 1913, we find that the predominant elements were in both years the minerals coal and gold, which were in 1905, and still are, jointly responsible for between 60 and 70 per cent of the value of the Indian mineral output; at the same time, the figures for these two minerals have undergone relatively a very significant change and one which we are justified in regarding as a true indication of sound industrial progress; for the value of the output of coal, which was in the earlier year little more than half that of the output of gold, overtook and passed the latter in 1907 and has increased from under 1½ million pounds sterling to over 3¾ millions, whereas the value of the gold produced has remained practically stationary throughout the whole period, and in the year 1913 was only two-thirds of that of the coal. As in nations, so in minerals, the prosperity of a country is to be gauged rather by that of its middle classes than by that of its aristocracy, and it is to the raw products for the commoner metallurgical and chemical

2. *Variations in value of the output of certain Indian minerals in the years* 1905 *and* 1913, *respectively.*

	1905.	1913.
	£	£
Coal	1,912,042	3,798,137
Gold	2,428,164	2,291,917
Petroleum	604,203	1,034,586
Manganese	262,696	1,211,034
Salt	441.392	541,447
Mica	142,008	347,451
Lead	*nil*	71,597
Tungsten	*nil*	127,762
Monazite	*nil*	42,012
Tin	9,916	46,401
Iron-ore	5,257	39.608
Silver	*nil*	15,338

industries that India must look for its ultimate mineral development. That many of those raw products occur in large quantities in certain parts of the country is a fact that is no doubt familiar to the members of this Institute, but it will be interesting to enquire how far such products have been developed since the presidential address to which I have alluded was delivered in the year 1907. In that address Sir Thomas Holland enumerated certain metals the ores of which seemed to offer prospects of profitable development in the near future, and a glance at the respective positions in the two years, 1907 and 1915, will help to give us a clue to the extent to which we have progressed or otherwise in that period. The chief metals to which reference was made are iron, copper, manganese and aluminium. With regard to the first, the output of ore had in 1907 been practically stationary for many years at the insignificant average of about 80,000 tons per annum, while the value of the annual imports of manufactured iron and steel had averaged nearly sixteen million pounds. Similar conditions prevailed until the year 1911, when the average output was almost quintupled owing to increased production by the Tata Iron and Steel Company, whose works at Sakchi were brought into operation at the end of that year, and are producing iron and steel in considerable quantity, including over 25,000 tons of steel rails in the year 1913. A new discovery of a large body of iron-ore has also enabled the Bengal Iron and Steel Company to extend their works at Barakar, and I think we have now reason to hope that the iron and steel industry for which India was once so famous, is in a fair way to be once more established in the country. So far, therefore, as iron is concerned, we may fairly claim that there has been solid progress during the past eight years. Clearly, however, we have only got our feet so far on the first rung of the ladder, and it must be many years before we shall have climbed high enough to grasp an appreciable share of the huge sums now paid annually for iron and steel manufactured abroad. The value of the imports of these materials amounted in 1913 to over twenty millions sterling, exclusive of cutlery, and with all the raw materials available in India, there is a very wide field for the development of local industry. The paucity of skilled labour is undoubtedly a serious drawback, and it must be long before a suitable class of indigenous operatives can be evolved, but this should be only a question of time.

Of copper it is impossible as yet to speak with equal hopefulness, but there are indications that a considerable industry in this metal may be established before long. At the time when Sir Thomas Holland's address was delivered, in 1907, the Geological Survey Department was engaged in putting down borings at various points in the belt of cupriferous rocks which runs through Singhbhum; the results of these trials were sufficiently promising to encourage the Cape Copper Company to carry out an exhaustive series of prospecting operations over the neighbourhood and subsequently to proceed with systematic development. A company has also carried out a considerable amount of exploitation in Sikkim, but we cannot yet say that copper-mining in India is a proved success, although there is every reason to hope that it is going to be so and that in the course of the next two or three years such a statement may be possible.

Of aluminium there is unfortunately nothing to be said. The deposits of bauxite in the Central Provinces have been prospected to a considerable extent and some areas have even been taken up for mining purposes, but so far there has been no production of either alumina or of the metal. The possibility of establishing a successful industry has been frequently urged in the publications of the Geological Survey, but local capital has not been forthcoming and those who have attempted to find capital abroad do not appear to have met with the success that the quality and accessibility of the raw material would seem to warrant. It is, however, probably but a question of time before the valuable deposits of the Central Provinces are utilized, and although the delay may seem to argue a lack of enterprise, this is certainly preferable to the premature and misdirected attempts at exploitation that have so often retarded the development of other minerals in India.

Of manganese there is little to be said except that the record is one of steady progress in production, which has risen in the interval with which I am dealing from a little over 300,000 tons to over 800,000 until India has become, with the possible exception of Russia, the greatest producer of manganese-ore in the world. Unfortunately, however, the trade is almost entirely an export one, the ore being exported in its crude state and only a very small quantity being employed in India. It has been pointed out more than once not only in the publications of the Geological Survey, but also in the publications of *Transactions*, that there ought to be room for the establishment of a profitable industry for the manufacture of ferro-manganese in India.

Although, of the four metals chosen by Sir Thomas Holland as bases of possible industries, progress has been marked only in the case of two, a glance at the list given in table 2 will show that considerable development has taken place in directions which could not have been anticipated so long ago as 1907, and the establishment of certain new industries of considerable value marks distinct progress in the mineral development of the Indian Empire. The lead mines of Bawdwin in the Northern Shan States, the tin and wolfram deposits of Lower Burma, and the monazite sands of Travancore have all provided new industries resulting in an annual outturn worth over a quarter of a million sterling. Although the Bawdwin lead industry was originally founded with a view to the treatment of rich lead slags containing also considerable quantities of silver and zinc, which were left by the Chinese miners who formerly mined and smelted the ores, further development is now being carried out in the mine itself, and it is to be hoped that this may result in the establishment on a sound basis of a lead-mining industry in Burma.

Two other minerals to which I have just referred, wolfram and monazite, have only quite recently been discovered in any appreciable quantity in this country, but they already form the bases of industries which promise to be of considerable extent and value. They both command high prices, since, although both are fairly widely distributed in nature, they are rarely found in sufficiently large quantities for profitable exploitation. Thus the present value of wolfram concentrates carrying 65 per cent of tungstic trioxide, WO_3, is about £100 per ton, while the monazite concentrates of Travancore are valued at between £35 and £36 per ton and are probably worth more.

The extensive commercial use of these two minerals is of only recent date, and as the literature on the subject is difficult of access to those engaged in mineral development in India, I propose to deal with them in some detail. They are also of interest at the present time in consequence of the fact that their metallurgical treatment has been carried out hitherto almost entirely in Germany, and they therefore furnish material for the development of new industries in the British Empire.

Wolfram, or, to give it its more correct name, wolframite, is, as you are no doubt aware, a tungstate of iron and manganese and the chief source of the metal tungsten, which is extracted from its ores by fusion with sodium carbonate and subsequent precipitation of tungstic acid from the sodium tungstate solution by means of hydrochloric acid. The valuable properties of tungsten steel have been known for over half a century, but it is only within the last few years that the metal and its various salts and alloys have been brought into general use. Tungsten itself is a heavy metal, with a specific gravity almost as high as that of platinum,—between 19 and 20. It has quite recently been discovered that although normally hard and brittle, the metal can be rendered perfectly ductile by means of repeated heating and swaging; it can thus be drawn out into wires of extreme fineness and remarkable strength, a wire of a diameter of $\frac{1}{250}$ inch having been found to stand a strain of nearly 200 tons per square inch. This property renders tungsten wire highly suitable for the manufacture of filaments for incandescent electric lamps, the ductile wire now replacing the filament formerly made of the compressed powder of the metal. Yet another recent improvement in this connection is the introduction of nitrogen into the bulbs, resulting in higher efficiency and a longer life of the wire, which, owing to the blanket of inert gas surrounding it, is less liable to loss of metal at the high temperature of incandescence

The chief value of tungsten, however, lies in the fact that when it is added to steel, the latter acquires the property of " self-hardening" and requires no tempering; it also retains its hardness at a red heat and is thus superior to carbon steel for the manufacture of high-speed cutting tools. Over four-fifths of the total outturn of tungsten is now absorbed in the manufacture, chiefly in the electric furnace, of ferro-tungsten containing between 50 and 85 per cent of tungsten, and amounts of carbon varying from ½ to 5 per cent. The steel of cutting tools contains from 6 to nearly 20 per cent of tungsten, a small percentage of carbon and small quantities of chromium and vanadium.

Tungsten is also used in the form of one or other of its salts—the tungstates—in various industrial processes, such as dyeing, fire-proofing, the differential analysis of tanning materials, and the manufacture of bronze colours.

The commercial supply of tungsten is derived chiefly from two ores, wolframite, with its varieties, ferberite and hübnerite, and scheelite. There are several other ores, but they are not at present of economic importance. The commonest ore is wolframite or wolfram, a hard and heavy mineral (hardness, 5·5; specific gravity, 7·5), with brittle and uneven fracture and sub-metallic lustre. It is dark grey to black in colour, and is a tungstate of iron and manganese (Fe, Mn) WO_4. It occurs usually in quartz veins in granite and in veins in schists or slates associated with granite. In many places, as for example in Burma, the wolfram lodes are associated with tin-bearing granites, though in this case the lodes are themselves, as a rule, free from tin-ore.

Next in importance to wolfram is scheelite, the tungstate of lime, $CaWO_4$. It is usually light-coloured, whitish or yellowish, but may also be brown, green or red. It has a specific gravity of 6 and a hardness of 4½ to 5. It occurs in crystalline rocks often in quartz-veins and associated with ores of other metals.

Ferberite and hübnerite may be regarded merely as varieties of wolframite, from which they differ in the predominance of manganese and iron respectively, hübnerite being a tungstate of manganese, with only an insignificant percentage of iron, whereas in ferberite iron predominates and manganese almost disappears.

Other natural tungstates are known of which the metallic base is copper, lead or iron, but these are at present of little or no economic importance.

Although of very wide distribution, the tungsten ores are not often found in quantities large enough for profitable exploitation; the chief countries in which they are worked at present are India (Lower Burma), Australasia (N.S. Wales, Queensland, New Zealand), United States, South America (Argentine, Bolivia, Peru), Portugal, and, to a small extent, England, Spain, Tasmania and Japan. Ores of tungsten have also been discovered recently in German S.W. Africa. Until comparatively recent years, the chief source of supply was the United States, but some five years ago the first serious attempt was made to develop the wolfram deposits of Tavoy and Mergui, and Lower Burma now heads the list as the world's greatest producer, while the United States, South America and Portugal share the honour of second place. The total production of the world is now about 8,000 tons per annum of concentrates carrying from 60 to 70 per cent of tungstic trioxide, WO_3. Of this Burma produces 25 per cent., Portugal, the United States and South America each 17 per cent, and Australia 15 per cent., the remainder being made up by the smaller producers, such as England, Spain and Japan.

The first record of the occurrence of wolfram in Burma dates back nearly three quarters of a century, to the year

1842, when Captain Tremenheere, one of the Hon'ble East India Company's servants, visited Mergui to report on the prospects of working tin; he found that the tin-ore washed in certain places was of an inferior grade owing to a large admixture of wolfram, and although subsequent references to the presence of that mineral both in Tenasserim and in Karenni are not infrequent, no steps were taken to prospect for it or to exploit the deposits until Mr. J. J. A. Page, a member of the Geological Survey, was deputed to Lower Burma to report on the local tin-mining industry. In the course of his investigations near Tavoy, Mr. Page discovered the wolfram-bearing lodes of Pagaye which have since yielded such large quantities of ore. After the Geological Survey had drawn attention to this occurrence, prospecting was taken up by the general public and during the five years, 1909-13, Lower Burma has produced over 5,000 tons of concentrates having a value of nearly £400,000; the years 1911-13 were responsible for practically the whole of this output, that of 1909 being only 7 tons and of 1910, 395 tons; the industry is therefore now little more than four years old, although the annual production has attained to nearly 2,000 tons of concentrates.

The ore, which always consists of wolframite, occurs primarily in veins composed chiefly of quartz but carrying also columbite, tourmaline, molybdenite and, very occasionally, cassiterite. These veins traverse granite and a series of metamorphosed sediments composed of slate, schist and quartzite, and known as the Mergui series. The granite, which carries locally considerable quantities of cassiterite, is younger than, and intrusive in, the Mergui series. It has been found that in Lower Burma when quartz veins carry wolfram, they are usually free from cassiterite, the latter mineral occurring in separate quartz-cassiterite lodes as well as in the granite. Occasionally, however, both tin and wolfram are found in the same lode, but this association appears to be exceptional.[1]

The wolfram-tin-bearing belt of granite and metamorphic rocks runs on northwards from Mergui and Tavoy into the Southern Shan States and is being exploited in Bawlake State; it probably extends still further north and a similar association may perhaps even be found again in the unexplored regions to the north of Burma, where granite carrying cassiterite is known to occur; there is not, however, any record of the presence of wolfram in the latter area.

In India wolfram has been found in various localities, but hitherto with one exception in only small quantities. In the Nagpur district a few hundredweights have been extracted from quartz veins traversing the Dharwar rocks of Agargaon, but the deposit has shown no signs of being more than insignificant. In Trichinopoly district isolated specimens have been found at Kadavur and Ururarkarad.[2] The most recent discovery is that of a deposit in Rajputana at Degana on the Jodhpur-Bikaner Railway.[3] The ore occurs with quartz and biotite in veins traversing granite, and although no evidence of a large deposit has yet been obtained, the result of such investigations as have been made is sufficient to warrant thorough prospecting of the locality which is, I believe, being carried out vigorously.

Although the expansion of the wolfram-mining industry in Burma has been extremely rapid and the profits very great, the methods employed in exploitation have for the most part been of the most primitive description. In addition to the quartz-wolframite lodes, float deposits provide a certain amount of ore, but the greater part is obtained from the lodes, which are usually worked by quarries and open-cut workings sometimes of a highly dangerous nature. The labourers are to a large extent Chinese and Telegus, with a sparse scattering of Burmese, who do not as a race take kindly to hard work of the kind involved in mining. The ore, when won, is with few exceptions crushed by hand and panned or sluiced. Concentrating machinery is almost unknown, but it will no doubt soon be introduced more generally, for the primitive methods at present in vogue are wasteful and must result in permanent loss, since much of the ore now left in dumps and tailings will for economic reasons be ultimately irrecoverable.

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[1] *Records, Geol. Surv. India*, XLIII, 78 (1913).

[2] *Records, Geol. Surv. India*, XXXIX, 279 (1910).

[3] *Records, Geol. Surv. India*, XLIV, 26 (1914).

Hitherto most of the wolfram produced in Burma has gone to Germany for metallurgical treatment; the industry has therefore been considerably disturbed during the last few months, but enquiries for wolfram were being made in London in December and the check to the industry will no doubt be merely temporary and of no serious importance.

I have already referred to molybdenite as being associated with wolfram in the quartz lodes of Lower Burma. This mineral is attracting considerable attention at the present time, as it is used, like tungsten, for special varieties of steel on which it has the same effect, but it need not be used in such large proportions. It is usually employed in the form of ferro-molybdenum, which can be produced directly from molybdenite in the electric furnace. It is also said to be used in the manufacture of explosives and to be therefore in considerable demand at present. The December price for material carrying 95 per cent. MoS_2 was over £600 per ton.

Molybdenite, which is a soft grey mineral, is easily mistaken at first sight for graphite; it is, however, very much heavier, having a specific gravity of over 8. It is said to occur in all the quartz-wolfram lodes of Lower Burma, but so far as is at present known, in quantities too small for profitable exploitation. But the value of the mineral, of which the greater part of the world's supply now comes from Australia, is so high that those interested in mineral enterprise in India would do well to keep the possibility of its discovery in view during the course of any prospecting operations they may undertake among the crystalline rocks. In spite of the fairly wide distribution of molybdenite, its usually sparse occurrence and the difficulty of concentrating the ore are the chief impediments to economic development. The flaky nature of the mineral renders concentration by water unsatisfactory, but good results have recently been achieved with oil.

Monazite, which is a phosphate of the rare earths cerium and lanthanum, owes its economic value to the fact that it contains also a certain percentage of thoria and constitutes the raw material for the production of thorium nitrate which is used in the manufacture of gas mantles.

Until quite recently the world's supply of monazite was derived from sands in Brazil, but the discovery of similar sands on the coasts of Travancore and Cochin has enabled India to enter the market and to create an industry worth over £40,000 in 1913.

The monazite, which is derived from the gneisses of the Travancore hills, is one of the constituents of the sands along the sea-shore, and in certain places selective action, by the waves, on these sands has led to local concentration of large quantities of monazite. The sand, which is still further concentrated by artificial means, was, until war broke out, exported to Germany, where the thorium was extracted for the manufacture of mantles. Other buyers will now have to be found for the sands, but this is not likely to be a matter of any difficulty.

Turning from metallic to non-metallic minerals other than coal, we find India in very much the same condition as it was eight years ago. We still lack the important raw materials for the manufacture of the most useful of all inorganic chemicals, sulphuric acid, such acid as is made in India being produced from imported materials; in the absence of deposits of native sulphur in India, there is small prospect of the development of an indigenous industry on a large scale until the smelting of sulphide ores becomes an established fact. A cheap supply of acid available for use at the coalfields would be a strong incentive to the utilization of those valuable materials which are now being wasted in most of the coke-ovens and to their recovery in the form of sulphate of ammonia and tar. It is many years since the East Indian Railway Company set up their recovery plant at Giridih, and it is rather remarkable that their example has not been more widely followed. This is no doubt partly due to the absence of a cheap supply of acid and to the conservative nature of the Indian cultivator, whose unwillingness to adopt any method not sanctioned by the immemorial usage of his country militates seriously against the introduction of artificial manures; but the demand for fertilisers is undoubtedly growing, although the imports in the year 1912-13, which were the largest up to that time, amounted to the insignificant total of less than 6,000 tons. It must be admitted therefore that the prospects of disposing of large quantities of sulphate are not as yet very encouraging.

Among the inorganic products the supply of which has been seriously affected by the present war, the most important are the salts of potash. Practically the whole supply of the world has been derived hitherto from the German salt-mines, and the danger of a possible potash famine has led to the development of numerous sources hitherto insignificant, but which have proved more elastic than might have been expected. At the same time the rise in price of the various salts has been so considerable —about 200 per cent.—that serious consideration is being given to the possibility of developing the deposits known to occur in association with the rock salt, in the mines at Khewra, Nurpur and other places in the Salt Range of the Panjab.

These deposits have recently been examined by Dr. Christie of the Geological Survey.[1] They consist of mixtures of kieserite ($MgSO_4.H_2O$), sylvite (KCl), and langbeinite, a double sulphate of potash and magnesia, with common salt. Bands containing these minerals occur among the beds of rock salt, but are not at present mined, and the total quantity available is unknown, though believed to be considerable. The seams, however, are, so far as at present prospected, rather poor in potash, the percentage of K_2O varying from 7 to a little over 14, over thicknesses of from $\frac{3}{4}$ to $2\frac{1}{2}$ metres. The question of the economic development of these deposits will also be seriously affected by the long and expensive railway journey from the Salt Range to the nearest distributing centres, although it is possible that the prevailing prices might be sufficiently high to permit of a profitable export trade being carried on during the period of the war. The establishment of a permanent industry on a sound economic basis must depend on the results of more extensive operations than have hitherto been carried out, but the matter has been receiving consideration for some years past and it is hoped that more detailed information as to the nature and extent of the deposits may be obtained before long.

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[1] *Records. Geol. Surv. India*, XLIV, 241 (1914).

It would have been impossible in the short time at my disposal to review in detail the mineral industries of India nor could I expect you to bear with me if I attempted to do so. I have therefore restricted myself to brief references to those minerals which have provided the raw materials for industries newly established in India and to a few others, not yet exploited, but which are at the present moment of especial importance, and which might offer prospects of profitable exploitation. I have not attempted to deal with the old established industries such as coal, petroleum and many others of less importance, all of which show steady progress. But a glance at the tables will show you that the mineral industries of India are in a thoroughly sound and healthy condition and give every promise of steady progress in the years to come.

Mr. H. C. Read then proposed a vote of thanks to the President for his address. This was seconded by Lt.-Col. F. Cunynghame Hughes and then carried unanimously.

Mr. G. Miller proposed a vote of thanks to the Asiatic Society for their kindness in permitting the meeting to be held in their rooms. This was seconded by Mr. Yeoman and carried unanimously.

It was then decided that, on account of shortness of time, the reading of the papers which were to have been brought before the meeting should be postponed ; it was also decided to postpone the discussion of papers already read, until the next meeting which, it was generally agreed, should be held some time in February.

EXCURSION.

At the kind invitation of Messrs. Bird & Co., several members visited their Northbrook and Dalhousie Jute Mills on Friday, the 29th January, 1915. Messrs. Bird & Co. kindly provided launches to take the party up the river and back, and the Institute is deeply indebted to them for their kindness and hospitality.

Asansol Meeting.

The first Ordinary General Meeting was held at the Railway Institute, Asansol, on Monday, the 22nd February 1915, at 10-20 a.m.

Present:—Dr. H. H. Hayden, President (in the Chair), Messrs. G. F. Adams, R. S. Ashcroft, R. Barrowman, R. J. Browne, R. F. Campbell, N. M. Chaudhuri, W. C. Clements, A. J. Cooper, A. T. Creet, Glen George, A. H Higby, J. S. Kean, J. Kirkwood, C. H. McCale, A. G. Mackay, J. Mackintosh, F. T. Marley, G. Martin, J. A. Millar, Geo. Miller, A. Russell, Thos. Samson. E. S. Tarlton, H. M. Tarlton, J. J. Turnbull, H. Walker, A. H. Wills, J. Wilson, and H. H. Reynolds (Hon. Secretary).

After reading the notice convening the meeting, the Chairman called on Mr. Walker to give an abstract of his paper on the Geological Re-survey of the Raniganj Coalfield which had on a previous occasion been only partially read. He asked Mr. Walker particularly to explain the principles he had employed in correlating the seams on the west with those on the east of the field, so that the members of the Institute might be in a better position to discuss the paper.

DISCUSSION ON MR. WALKER'S NOTE ON THE GEOLOGICAL RE-SURVEY OF THE RANIGANJ COALFIELD.

Mr. H. Walker in introducing the paper said the map of the coalfield owed its changed appearance not so much to changes in the geological boundaries as to the large additions to our knowledge of the coal seams. The alterations in the geological boundaries were of minor importance and were to be found on the margins of the field where deforestation had made field-work much easier than it was in Dr. Blanford's time. The alterations were pointed out on the wall-map.

The question of the correlation of the coal seams was the most important one. He briefly recapitulated his reasons for not attempting a correlation of the seams in the Barakar Series. The case was different in the seams of the Raniganj Series. A glance at the map would show that, with regard to the lower seams, an unbroken sequence had been found from Dishergarh in the west, through Charanpur in the centre, to Saikpur in the east. The question at issue was:—On the information available can the seams found to the east of the Badul Fault be correlated with those of the established series occurring to the west?

In attempting to solve the problem it was necessary to have some datum line to which information from boreholes and workings could be reduced. Unfortunately the available maps were uncontoured and whilst the information of any particular property was reduced to one line of reference it was not coordinated with the information of neighbouring properties. One other method remained, viz., to use the junction of the Raniganj Series with the Ironstone Shales. This is not an ideal reference line, because, in field-work it was found to be a difficult matter to decide where the Ironstone Shales ended and where the Raniganj rocks began. Furthermore, as far as I am aware, only one borehole has been put down through the lower members of the Raniganj Series into the Ironstone Shales. This borehole was put down by Messrs. Bird & Co. in their Chinchuria (eastern) property, and from the cores obtained it was evident that no sharp passage from shales to coal measures existed, thus bearing out the field-work. The tables on pages 249 and 250 have been compiled from available information and with the base of the Raniganj Series as the line of reference.

In table No. 1 a secondary datum line has been formed on the supposition that the seam variously known as Gangutiya and Taltor is represented to the east of the fault by the 5′ 9″ seam of Chinchuria and neighbourhood. This, in effect, is a supposition that the seam retains approximately the thickness throughout the length of the field—a supposition not borne out by the known thinning from west to east of the Sanctoria and Dishergarh seams. The correlation also introduces a thickness of approximately 250 feet of strata between the Koithee and Sibpur seams with an important seam, varying in thickness from 5′ 6″ to 8′ 0″, which has no counterpart to west or east. Further criticism of this correlation is to be found in the body of the paper.

Table No. 2 was drawn up on the basis that the first seam above the Ironstone Shales to the west of the fault was represented by the first seam above the shales to the east—the Taltor Seam by the 1′ 9″-2′ 0″ or Farewell Seam. This correlation I consider to be the correct one, for it gives effect, in a general way throughout, to what we know to occur to the west of the Badul Fault, viz., a thinning of the lower seams as they pass from west to east. Furthermore, it provides for the thinning in the westward extent of the thick seams which are found to the east of the fault.

An explanation of these variations in thickness may be found if we consider the basin of the coal-field to have been in a state of movement. In the early stages of the

Raniganj period the western portion was either stationary or sinking slowly, whilst the eastern area was shallow and rising. The result was good sedimentation in the west and less sedimentation in the east. In the later stages the movement was reversed A similar oscillatory movement would appear to have taken place in the Barakar period.

President : Gentlemen, I think Mr. Walker has made thoroughly clear the principles that he employed. He had apparently two alternatives, either to take as a basis one particular seam which is fairly constant throughout the western area and correlate it with a similar seam in the east—that was one alternative ; the other was to apply the principle which he had found actually to exist, namely different movements in two parts of the basin, involving sinking at first in the west with a simultaneous rise in the east, and subsequently the exact reversal of these conditions. I suppose really one could do great deal juggling with a table of this kind based mainly on the thickness of the seams, and it is very difficult to put any very firm reliance on, or to draw any very satisfactory conclusions from, a correlation based on mere thickness as you find. Mr. Walker's idea of a differential movement, resulting in an accelerated rate of coal formation at one particular time on one side of the field and retardation on the other, is a very ingenious idea. I do not think, however, that purely lithological methods of correlation will ever enable us really to get to the root of the matter. It is not so much physical character as the composition based on chemical analyses,—such character as amount of volatile matter, moisture, etc., and also perhaps the microscopic structure of the coal,—that will give us a clue to the true correlation. In recent years a great deal of valuable work has been done in determining the nature and origin of coal by means of examining sections under the microscope. Until we have made both quantitative analyses of the seams and microscopic examination of this section, I do not think we shall be in a position to arrive at a true correlation.

Mr. Glen George : Mr Walker mentions in his paper the Laikdee Seam, which presents features of considerable interest. It is a seam 90 ft. thick containing 4 shale bands, each two feet or so thick. It occurs at Laikdee, two miles west of the Barakar river at Barakar, and has been worked by the Bengal Coal Co. and Messrs. Bird & Co. Towards the west it probably splits up into the several thick seams known there—such as the Jamdeeha Seam.

To the east of Laikdee it is cut off by a fault of four hundred feet throw. East of this fault at Chirkunda, the seam is split up into five seams, varying from 10 ft. to 20 ft. in thickness.

Along the Barakar River itself, the Seam is again cut off by the large Barakar Fault. East of this fault—at Ramnuggar—the five seams have again come together and form one large seam.

I would disagree strongly with Mr. Walker's statements and references to the Deshergarh Seam being found in a boring near Jamuria. The Deshergarh Seam has a gradual but steady thinning proceeding along its outcrop from west to east. At Sanctoria it is 20 ft., at Sodepore 16 ft., at Bura Dhemoa 12 ft., at Nuni 8 ft. East of Samla Dyke, it becomes as thin as 3 ft. and eventually vanishes. Borings in Pariharpore have failed to prove any seam even corresponding to it.

I would suggest that Mr. Walker in his interesting paper has not laid sufficient weight on the importance of the Raniganj Ekra Badool Fault, i.e. a disturbed zone running from Raniganj Station through Ekra Station—roughly N. and S.

Two instances of the local effect of this fault may be mentioned. 150 yds. west of Raniganj Station, the Searsole and Raniganj seams exist undisturbed and in their full thickness : east of Raniganj Station boring has failed to locate them. In the same way, west of Ekra Station, the Seebpore Seam, while thin—8 ft.—is readily recougnizable and is worked.

East of Ekra, there is at least a considerable barren area and it is doubtful whether the seam exists anywhere on this side.

East of the Raniganj Badool Fault, thick seams are the rule—the Topsi 27 ft., the Bowlah 40 ft., the Parascole, 40 ft. West of this fault the thickest seam in the Raniganj measures is 20 ft.

The question as to the extension of the Seebpore Seam east of this fault is dealt with at some length and with great interest by Mr. Walker, and the point is one of considerable importance. The best that I think can be said is, that the identity of the Chinchuria-Sonepore 5 ft. Seam with the Seebpore is doubtful and that, owing to the excessive moisture in the Chinchuria-Sonepore Seam, if the seams are identical, their qualities differ greatly.

Mr. J. Mackintosh : I should like to make a few remarks on Mr. Walker's paper. The first point I notice is Mr. Walker's statement that no seam of coal appears between Chanch and Laikdee. This I think is not correct.

In the Patlabarrie Mouzah west of the Khudia nullah. three seams of coal have been worked, first the Chanch

Seam, second the Patlabarrie B Seam, 40 feet thick; third the Patlabarrie A Seam, 8 feet. North of this a few years ago a boring was made and an outcrop of 80 feet of coal was passed through.

Crossing the Khudia nullah to the east we have four seams outcropping: the first is the Chanch Seam, the second is the Junkhudar Seam corresponding with the Patlabarrie 40-feet Seam; thirdly the Jegraj Seam, 8 feet thick, corresponding with Patlabarrie A Seam; and fourthly the Laikdee Seam. If these two seams—Patlabarrie B Seam and Patlabarrie A Seam—occur between the Laikdee and Chanch seams then the section at Borrea and Salanpur agree, but if these seams do not come between Laikdee and Chanch then the sections will not correspond.

Mr. George apparently agreed with Mr. Walker (as he said the Patlabarrie B Seam was the upper half of the Laikdee Seam), but I am of the opinion that the Patlabarrie B Seam is a totally different seam. A boring was made some years ago in Laikdee and proved the 40-feet seam; it is also worked at Borrea by the New Beerbhoom Coal Co and at Salanpur. Some confusion occurs with regard to the borings at Salanpur, inasmuch as this seam is reported in some of the boring records as three separate seams, but if these records are examined carefully it is found that the partings between the three seams are dyke and jhamma and should have been reported as all one seam.

Mr. Walker also remarks that the Salanpur Seam appears to be lower in the measures than those worked at Borrea. Which seam does Mr. Walker mean by *the Salanpur Seam,* as there were four different seams worked at Salanpur? If Mr. Walker means the Salanpur A Seam then I agree with him, but if he refers to the upper three seams, I am of the opinion that these are the same seams that are worked at Borrea, and I believe the thick seam has been found in borings there. (Borrea.)

I have nothing further to remark, but there are many other points that might be discussed, and I think the discussion might be continued at another meeting.

Mr. Adams: Would Mr. Russell tell us what seams are being worked in Borrea Colliery?

Mr. A. Russell: In Borrea Colliery we are at present working three seams which we call our 3rd, 4th and 5th seams, and represent the 35′, 5′ and 15′ seams given in the Pundurriya compiled section shown in Mr. Walker's paper.

Mr. Adams: Would Mr. Russell show us here on the map where these seams are being worked?

How many seams are there?

Mr. Russell: Our Borrea Colliery work the seams between this large fault dividing Lall Bazar from Pundurriya and the large dyke shown on the east..

There are five seams: the upper two (the 1st and 2nd) have been worked out, and as already mentioned we are now working the 3rd, 4th and 5th seams.

President: Do you think those five seams to be the Laikdee Seam?

Mr. Russell: I think so.

The large fault shown here is a down throw west into our Lall Bazar property, which fills the gap between Pundurriya and Ramnagor. This property has been protected and two shafts sunk into the 1st seam 8′ thick; this with the 2nd seam of 5′ may represent the Ramnagor Seam or upper portion of the Laikdee Seam. There is only 2′ 6″ of stone between the seams to the dip west of the property ; the appearance and quality of the coals are very much alike.

Mr. G. F. Adams : Mr. President and Gentlemen,—I am afraid that my detailed knowledge of the Raniganj Coalfield is not sufficient to enable me to enter into this discussion as regards the correlation of the seams. All I would ask is that we must not regard Mr. Walker's paper as the last word in this matter. We have now got the 24 big sheets you see in front of you, and there is no doubt that papers to fill in details might be written on each one of them by anyone living in that particular locality and possessing therefore particular local knowledge. I think also that our knowledge of this coalfield will be enhanced if we can have more sections. I think if members who have them would send to Mr. Walker longitudinal or vertical sections, I feel sure he will give us another paper as an appendix to this one.

REPLY TO THE DISCUSSION.

Mr. H. Walker : There is one point which escaped me at the time and which has been brought to mind again by Dr. Hayden's remarks. The question may be asked—Why do I regard the 1′ 6″-2′0″ seam of Chinchuria as equivalent to the Taltor Seam and not as equivalent to one of the thin seams which are found below the Taltor Seam at Charanpur. I have Mr. George's authority for stating that a boring was put down to a depth of 600 feet in the mouza of Hejulgorah and no coal was found This I think proves that the thin seams at Charanpur may be regarded as local stringers. This borehole also gives weight to my statement that a decrease in sedimentation in the lower stages to the east has been accompanied by a decrease in the deposition of coal.

In answer to Mr. George's question as to where I got the information that the Dishergarh Seam thins to the dip, I must reply that I do not know now. Mr. Millar evidently agrees with me that, in parts, the seam does thin to the dip.

The opinion of Dr. Saise concerning the seams to the east of the Badul Fault, related to us by Mr. George, is very interesting. That there must be a large fault would appear to be necessary in view of the enormous thickness of Panchet rocks disclosed by the boring at Durgapur. I should expect such a fault to have a very marked effect on the Barakar rocks at the margin of the field to the north, and I do not think the Badul Fault has such an effect. My idea is that the fault lies to the east of Badul and is hidden under the laterite and alluvium.

I am aware of the high percentage of moisture contained by the coals to the east of the Badul Fault alluded to by Mr. George. Possibly the explanation is to be found in the presence of the laterite which is so widely spread in that part of the Field.

Mr. Mackintosh has given important information concerning thick seams underlying the Chanch seam. The information is new to me, and I should very much like to receive it in detail.

I shall be pleased to take up Mr. Adams' suggestion and proceed with the preparation of sections across the coalfield.

* * *

Jharia Meeting.

The second Ordinary General Meeting of the Institute was held on the Jherria Coalfield on Monday, March 22nd, 1915. The meeting took the form of a geological excursion conducted by the President. A considerable number of members attended. Mr. H. Read, Professor of Mining at Sibpur College, also brought 18 members of his mining class. The members met at Pathurdih Railway-yard at 9 a.m., and proceeded thence eastwads to Bhulanbarari, where the coal-measures, dipping steeply northwards, abut against the tongue of crystalline rocks which protrudes into the south-east corner of the coalfield. Some interesting, highly indurated conglomerates were found at the junction, and were regarded as Talchir conglomerates altered and hardened by intrusions of mica-apatite-peridotite, several dykes of which are found in the neighbourhood. As a rule the Talchirs are poorly exposed in this part of the field, being usually overlapped by the Barakar sandstones. To the east of Bhulanbarari, however, a good section is exposed in the Chatari Nala, near the village of Jugan. Here conglomerates and typical green Talchir shales are found. The total thickness of Talchirs, however, is inconsiderable, most of the beds of that stage being overlapped. Sections of the conglomerate are also seen in the field surrounding the village of Jugan.

From this point the members turned south and crossed the tongue of crystalline rocks to the boundary of the coal-measures in the neighbourhood of the village of

Koriatand, where the Talchirs have been completely over lapped by the Barakars; the latter lie directly on the gneiss, the junction being a very instructive one and offering an excellent example of unconformity. From this point the coal-measures were followed along the bed of the stream through a gradually ascending section to Chasnala. Several coal seams were examined, and good examples of the destructive effects of the mica-apatite-peridotite dykes on the coal were observed.

The following is a list of the members who attended the meeting:—

H. H. Hayden (*President*), G. F. Adams, A E. Arratoon, W. Augier, R. G. M. Bathgate, R. Barrowman, E S. Bennertz, D. Blair, A. C. Banerjee, R. J. Browne, G. Castles, C. A. Crofton, Dr. L. L. Fermor, H. G. Graves, R. Heron, H. Cecil Jones, G. C. Leach, A. G. Mackay, J. Mackie, Guy E. Pilgrim, H. A. Pringle, H. C. Read, W. J. Rees, A. Russell, R. R. Simpson, E. S. Tarlton, A. S. Thompson, G. H. Tipper, J. J. Turnbull, Thos. Walsh, and Jas. Wilson.

CURRENT LITERATURE.

Modern Developments in Hydraulic Stowing and Suggestions for its application in British Collieries. By J. DRUMMOND PATON, *Trans. Inst. Min Engrs.*, Vol. XLVII, pp. 468-505.

Deeper mining; the recovery of seams of coal under cities, rivers, buildings, railways and surface water; the exhaustion of the best coals; and the need for greater care and economy in working thick seams, are matters that are forcing the question of hydraulic stowing on the daily notice of mining engineers. It only needs pioneering influence of some good examples in the country to make the system popular. The badness of the roof or floor under contact with water does not preclude its use The man at the surface controls the supply by the sound in the pipes and is able to forestall instructions received from underground.

The principle of hydraulic stowing is the flushing of suitable and not too large-sized material, by means of running water through piping into the goaf and disused roads. The method entails some inconveniences which increasing experience will eliminate, but they are of no account compared with the advantages, not only for coal mining but for all other kinds of mining. More especially is this the case with very thick seams. At the present time, now that the method has been so widely and successfully adopted, the principal objections are connected with obtaining the necessary supply of stowing material, the excessive wear of the pipes, and the difficulty of clarifying and lifting the stowing water. With hand stowing goaves are only packed up to 45% of the space, but with hydraulic stowing 90% can be obtained. Twice the amount of stowing material is thus required and this speedily absorbs the waste material from the pitstead heaps. Blast furnace granulated slag is excellent material if available. One Colliery near Duisburg uses 1,800 to 2,900 tons daily. Quarries have to be opened to supply what is wanted and then questions of transport come into consideration. The author deals in some detail with these problems and shows that cooperative working both in special quarries and in railways have been adopted with success.

The wear of the piping employed is one of the serious factors. Unlined mild iron pipe is generally preferable to steel, but now very extended use is made of a special porcelain lined pipe. This is made in lengths of 4 to 5 metres and diameters of 125, 145, 163 and 185 millimetres. The price per metre of 145 mm. diameter pipe in 5-metre lengths is 24 marks f. o b. at Rotterdam and it weighs 45 killograms per metre. (That amounts to about Rs. 5¾ and 27lb. per foot for six inch pipe). Another form of piping largely used is made of mild steel of oval section with a mild iron lining which can readily be changed when worn. The prices f. o. b. Rotterdam is 26½ marks per metre for pipe corresponding to a circular pipe of 150 millimetres bore. On the whole the author favours this type. Cast iron pipe is no good.

The material used for filling purposes is preferably crushed to 30 or 40 millimetres cube, i.e. ¾ to 1 inch, but 3 or 4 inch cube sizes are sometimes used. The danger of choking the pipes is less with the smaller sizes and the pipe diameter may be reduced. But smaller sizes than ¾ inch is not advisable, specially with loamy or clayey material, as the clarification of the water becomes difficult. Extensive crushing plants, with screening arrangements to reduce the labour of crushing unduly, and hoppers to hold the products, have been installed. Three of these are described in some detail.

Next the author discusses the question of clarifying the water before it is pumped to the surface. With clayey material there may be a loss of 5 to 10 per cent of the stowing material carried away by the water, so special sumps and standages have to be arranged. Matters have progressed so far that even pneumatic lifts for sludge have been utilized to clear out the settling places.

In Germany about a hundred mines have adopted hydraulic stowing and the process is widely used in Belgium, France, Spain, Austria-Hungary, Russia, Poland, Pennsylvania, Western Australia, the Transvaal and Canada. Costs vary between 0·6 and 2·0 marks per cubic metre or per ton and average 1·20 marks, or say 14 annas per ton.

H. G. G.

Wet Shafts.—An interesting account is given by R. G. Gibson in *Coal Age* of a method by which the flow of water in a wet shaft was reduced from about 600 galls. per minute to a pint. The method employed involved lining the shaft with reinforced concrete and filling the spaces between the lining and the walls with grout forced in under pressure. In this way a great saving was effected in cost of pumping. *Coal Age*, Vol. 7, No. 1, Jan. 2, 1915, page 2.

Vanadium Steel.—In the issue of the *Iron and Coal Trades Review* for December 25th, 1914, there is an abstract of particulars on the subject of certain possibilities in steel construction by the use of high alloy steels given by Mr. G. L. Norris at a meeting of the American Society of Civil Engineers. Mr. Norris, who is metallurgical engineer to the American vanadium company, referred chiefly to the question of the production of steel with high elastic limits of from 60,000 to 100,000lb., and claims that such steel can be produced only by the use of alloys, of which he regards vanadium-iron or chrome-vanadium-iron as probably the most suitable. He states that a chrome-vanadium steel containing from 0·17 to 0·27 per cent carbon, 0·40 to 0·60 per cent manganese, 0·60 to 0·90 per cent chromium, not more than 0·005 of either sulphur or phosphorus and not less than 0·15 per cent vanadium, would have, when rolled in the form of plates, shapes and bars, an elastic limit of 60,000 to 80,000lb. and a tensile strength of from 85,000 to 100,000lb.

Use of mud-laden water in drilling.—At the New York meeting of the American Institute of Mining Engineers, Mr. I. N. Knapp read an interseting paper on the use of mud-laden water in drilling wells. This referred chiefly to the use of rotary drill in porous ground, into which clear water will sink indefinitely; if, however, water well charged with a good clayey mud be used for circulating through the drill, the porous strata become speedily clogged and thus rendered impervious and drilling can be continued without appreciable loss of water. *Bull. Amer. Inst. Mining Engineers, Dec.* 1914, *p.* 2783.

In a paper published in the *Transactions of the Institution of Mining Engineers* (Vol. XLVIII, Pt. 2, p. 387), Mr. W. H. Hepplewhite discusses "substitutes for wooden support of the Roof in Longwall working.'' He deals with wooden, steel and concrete props. The paper gave rise to a considerable discussion of much interest.

In *Metallurgical and Chemical Engineering* (Vol. XIII, No. 1, January 1915, p 28), Mr. F. A. J. Fitzgerald gives the results of experiments showing the effect of the addition of small quantities of titanium to the steel used in the manufacture of rails. He concludes that the best results are obtained by the addition of at least 0·10 per cent of metallic titanium.

In an interesting article entitled "Electric Smelting in 1914", Mr. Robert M. Keeney refers to modern improvements in processes and furnaces for the production of steel, and also of zinc. Much attention has recently been devoted to the problem of substituting coke for charcoal in the manufacture of pig iron; this has been dealt with at some length and it has been shown to what extent progress has been made. Reference is also made to the production of steel directly from ore in the electric smelting furnace. The article contains numerous useful references to recent literature on the subject dealt with. (*Mining Press*, Jan. 2, 1915, p. 22.)

H. H. H.

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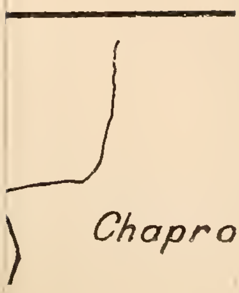

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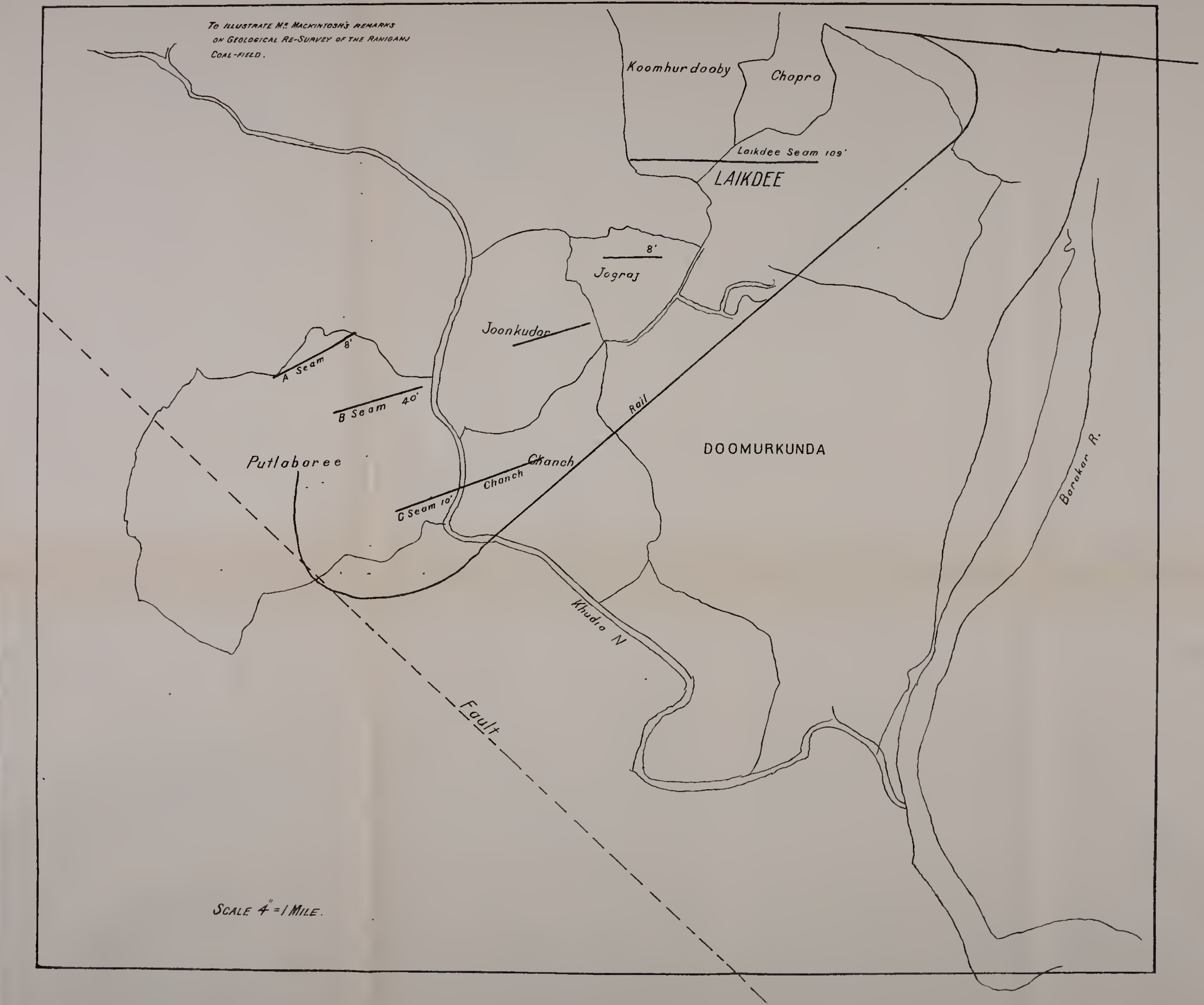

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